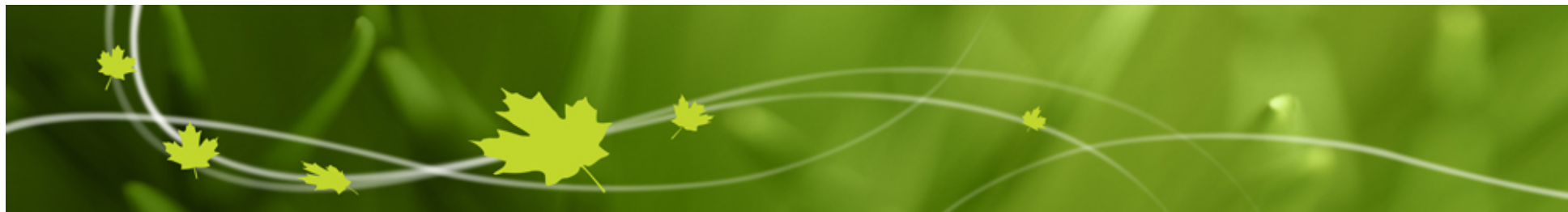




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Evaluation of the GPM DPR Level2 algorithm over Canada

D. Hudak, P. Rodriguez, and P. Joe
Cloud Physics and Severe Weather Section

2016 PMM Science Team Meeting, Houston, TX, October 24-28, 2016

Overview

- Physical validation of DPR L2 products over Canada
 - Great Lakes area
 - Complex orography (OLYMPEX)
 - High latitudes (Arctic)
- Development of an integrated observing system that combines ground based, satellite and airborne observations
- Supports hydrological and NWP applications e.g. IMERG into Canadian Precipitation Analysis



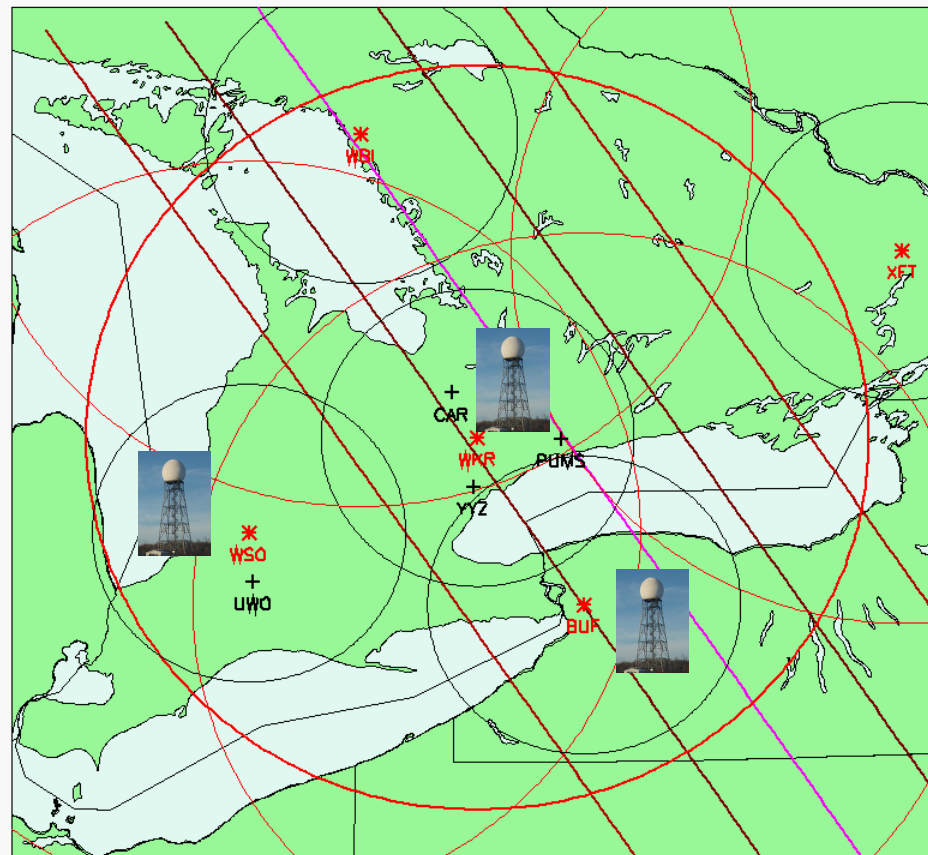


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Tier I Radar Studies

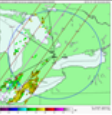
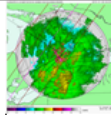
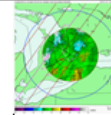
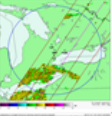
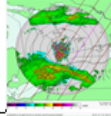
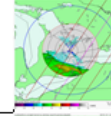
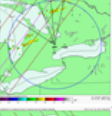
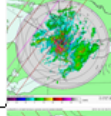
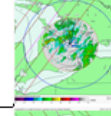
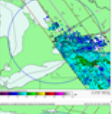
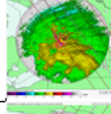
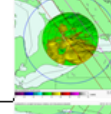
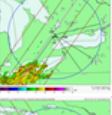
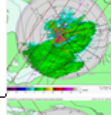
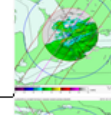
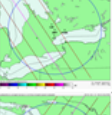
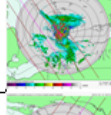
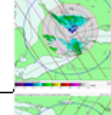
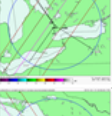
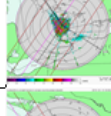
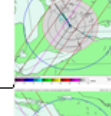
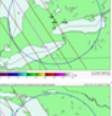
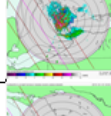
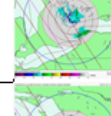

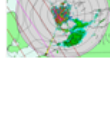



CONVDL coverage = 250km

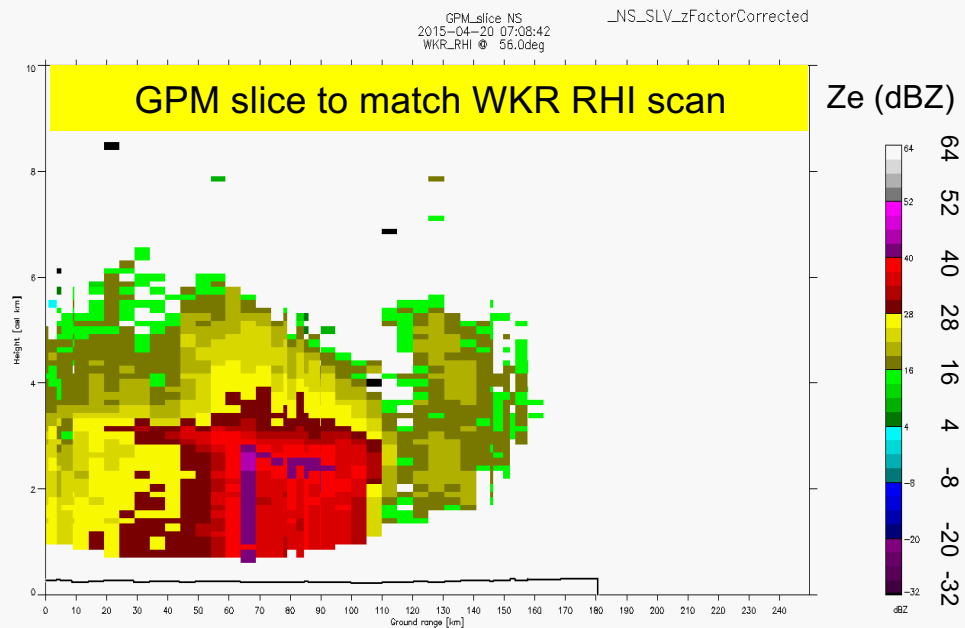
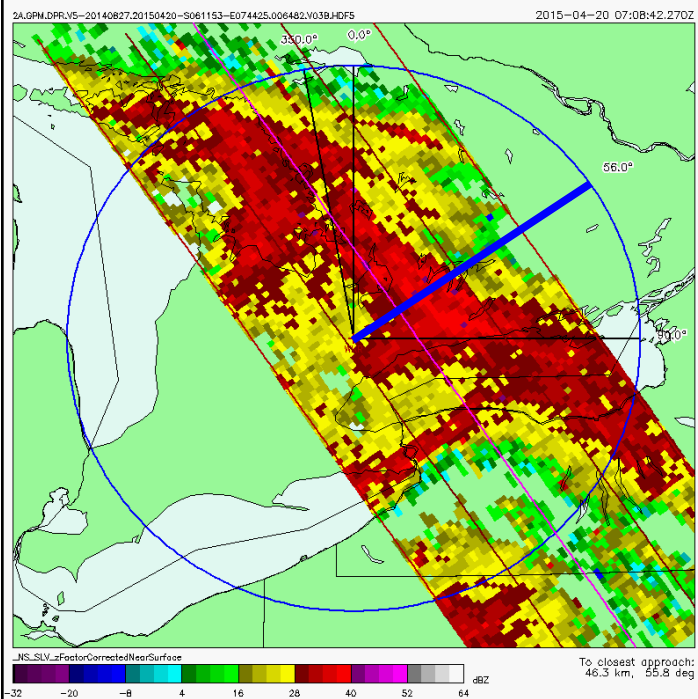
To closest approach:
46.3 km, 55.8 deg

GPM GV: WKR case library

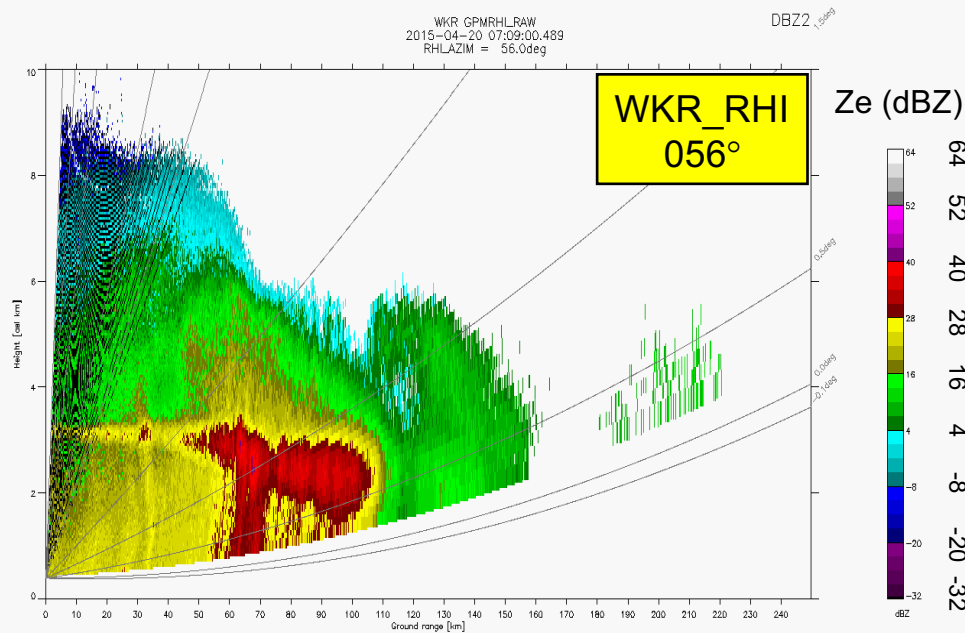
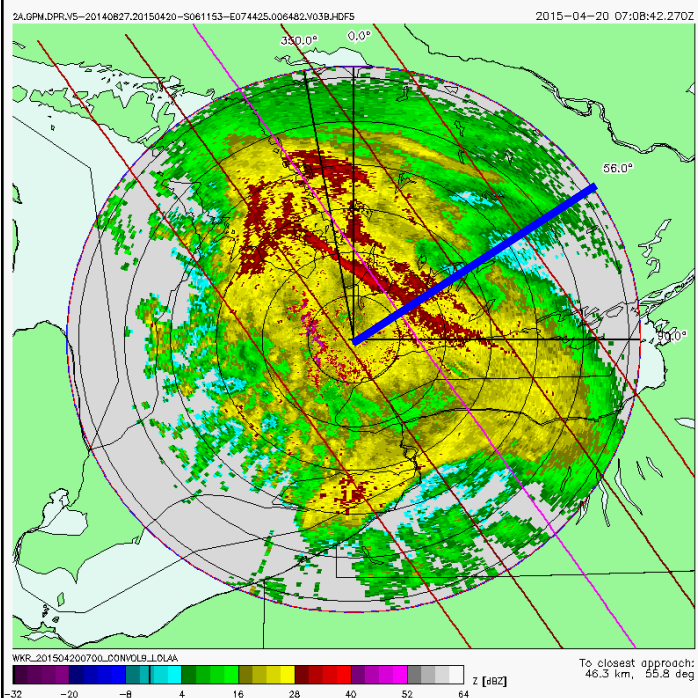
(115 up to June, 2016)

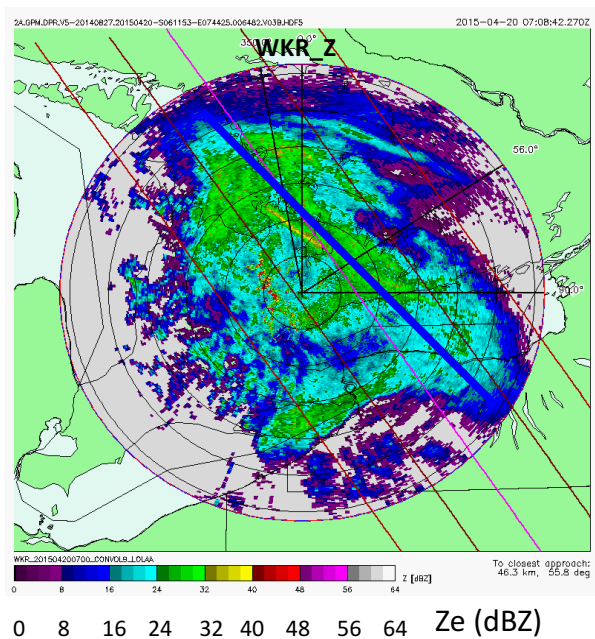
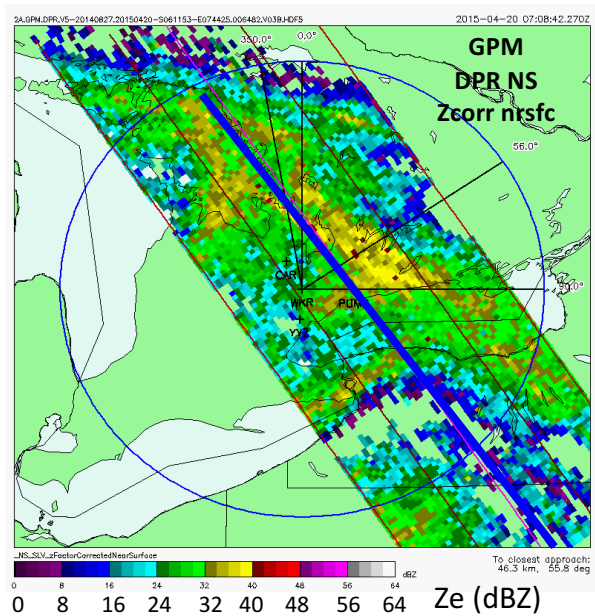
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Q	R
1	CASE	RHI	granule	GPM	CONVOL	POLPPI	Wx class	YYZ (51459) temp	YBN (48649) temp	YOO (48649) temp	YKZ (4841/53678) temp	CARE BB hgt	CARE BB thk	GPM swath WKR	GPM swath CARE	GPM swath YYZ	GPM swath PUMS
40	2015-01-09 0423Z	224.0,240.0,304.0,352.0	4909				synoptic snow	-10.3	-10.8	-8.5	-10.3	-1.676	n/a	Ku	Ku	Ku	
41	2015-01-12 0322Z		4955				synoptic snow	-1	-3.6	-0.8	-1.5	-0.825	n/a	Ku	Ku	DPR	DPR
42	2015-01-24 2351Z	304.0,340.0,355.0,11.0	5155				mixed showers	-0.8	0.3	-1.5	-0.8	0.116	n/a				
43	2015-02-02 0537Z	56.0,83.0,110.0,125.0	5283				synoptic snow	-14.2	-16.2	-15.4	-15.5	-2.289	n/a	Ku	Ku		Ku
44	2015-02-04 2031Z	76.0,124.0,145.0,214.0	5324				synoptic snow	-2.6	-6.3	-2	-2.8	-0.222	n/a	DPR	DPR	DPR	Ku
45	2015-02-07 0423Z		5360				snow showers	-5.2	-4.8	-4.9	-5.1	-1.596	n/a	Ku	Ku	Ku	
46	2015-02-12 1812Z	123.6,213.6,325.0,327.0	5447				lake effect snow	-14.9	-17.8	-15.5	-16.5	-2.427	n/a	DPR	DPR	DPR	Ku
47	2015-02-15 0204Z		5483				lake effect snow	-16.9	-19.1	-15.9	-17.5	-2.633	n/a			Ku	
48	2015-02-22 2350Z		5606				lake effect snow	-11	-14.7	-11	-11.4	-1.687	n/a				

GPM
DPR NS
Zcorr nrsfc

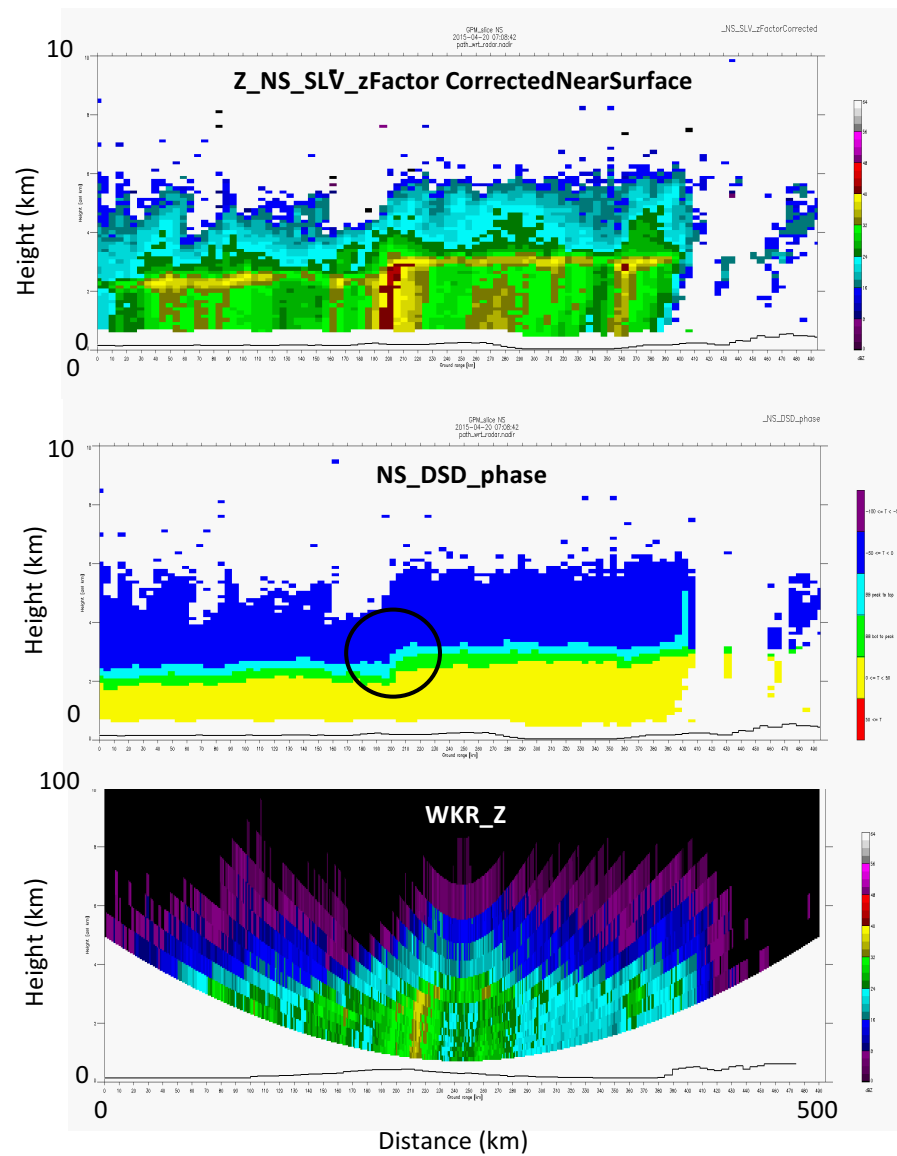


WKR Ze





Cross Section Along GPM Nadir

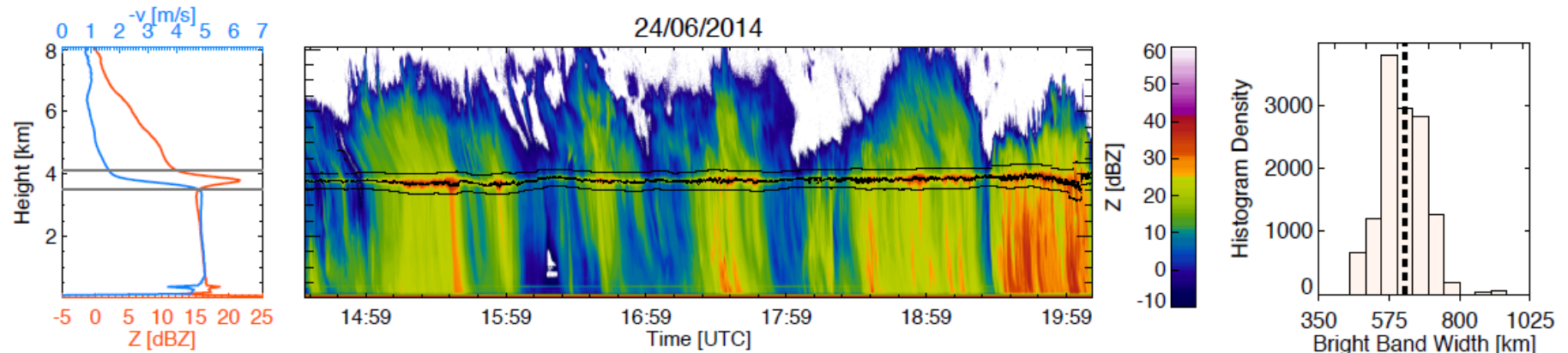


IV. Validation of GPM bright band detection using McGill vertically pointing radar

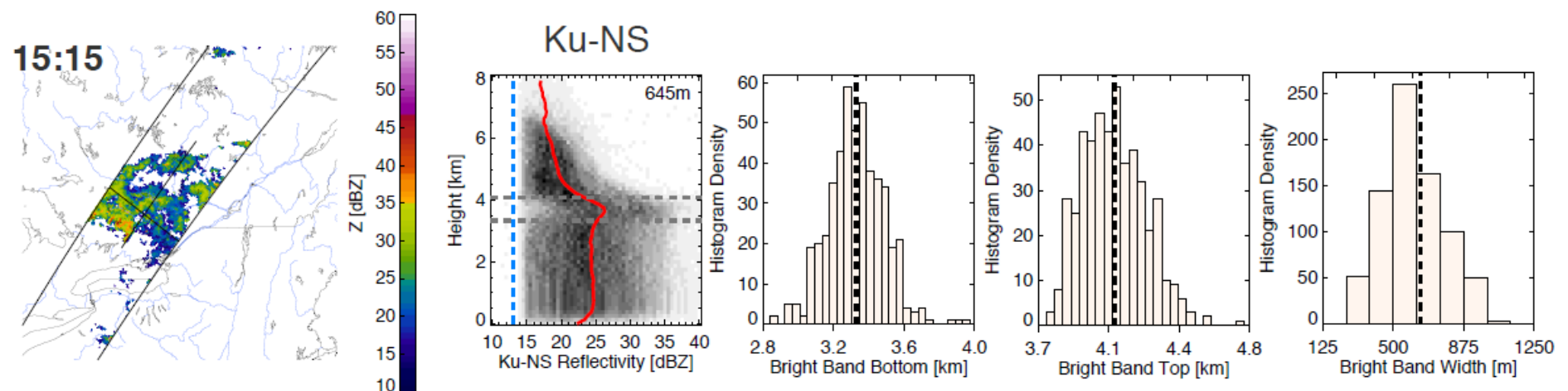
GPM bright band validation

Example case 24/06/2014

VertiX BB thickness - $624 \pm 66\text{m}$



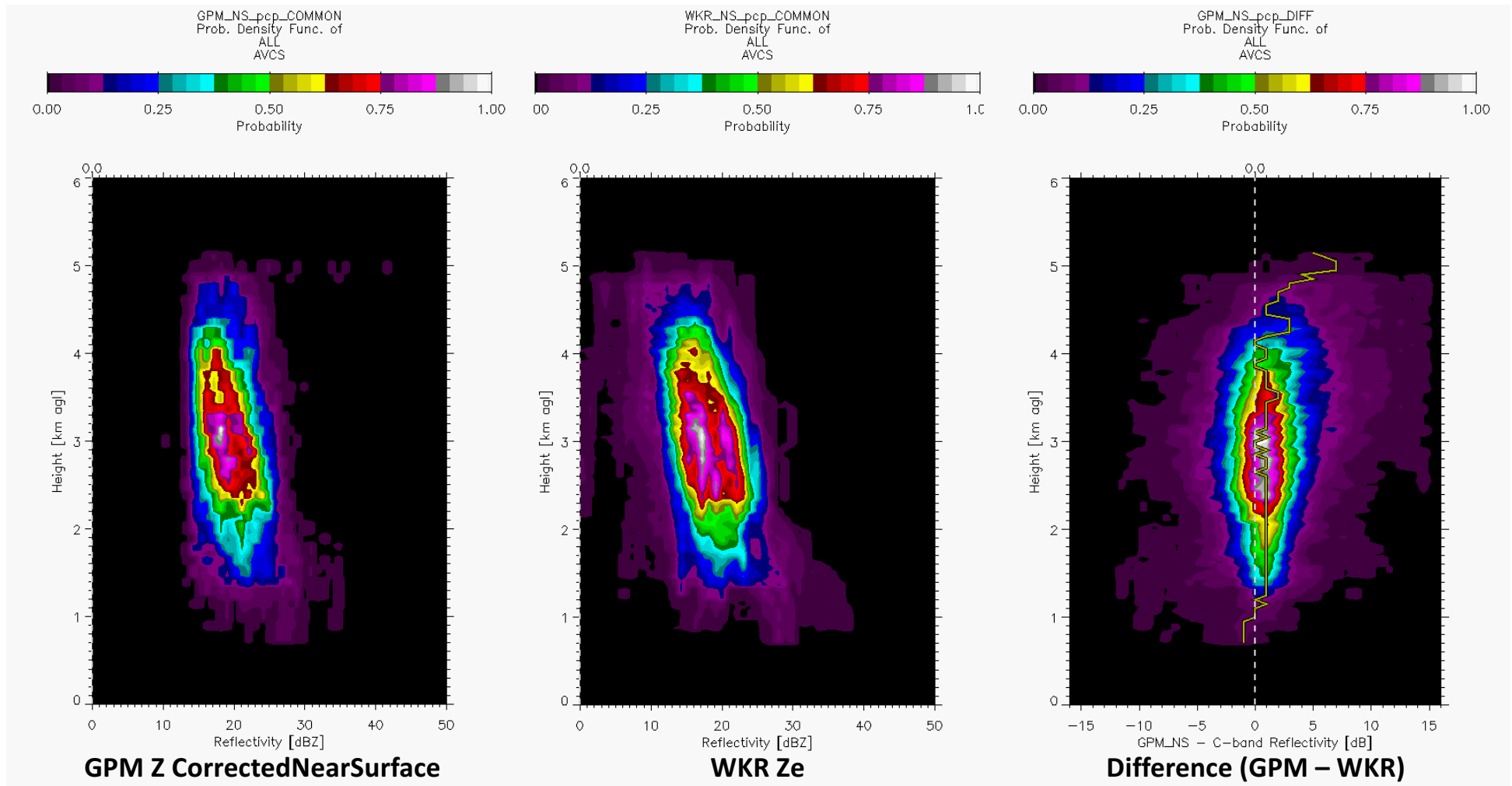
GPM BB thickness - $645 \pm 198\text{m}$



Courtesy Bernat Puigdomènech Treserras, McGill U.

Snow Cases

GPM vs WKR



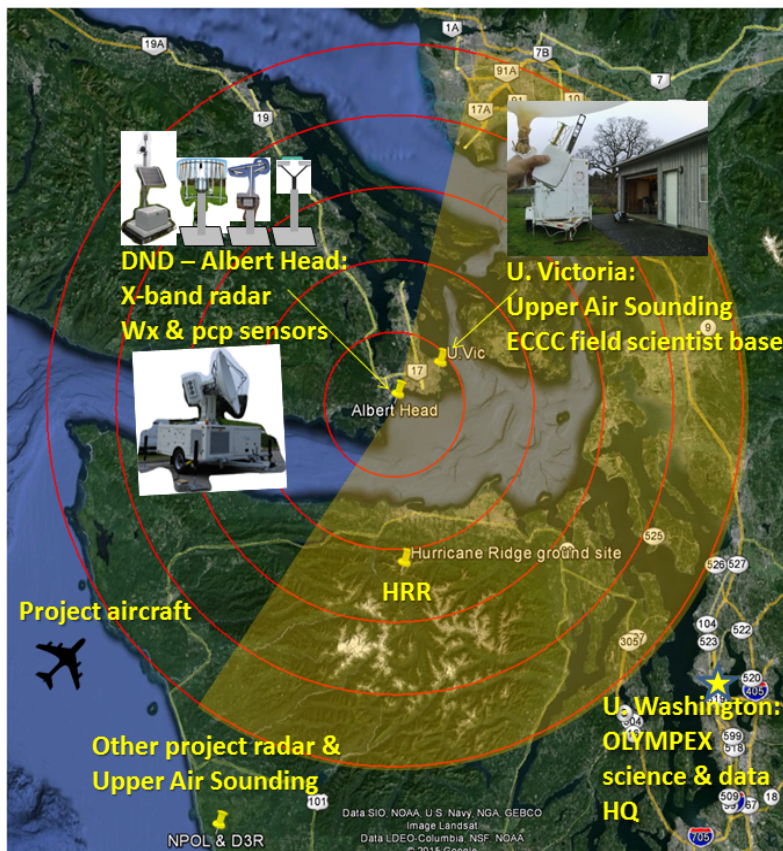


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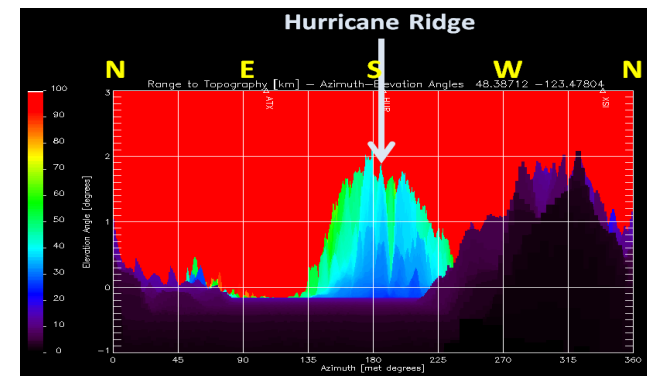
Canada

OLYMPEX Canada



Objectives

1. Contribute to microphysical studies of precipitation mechanisms over and to the lee of Hurricane Ridge



2. Evaluate GPM products in complex terrain
3. Support model validation and data assimilation in Canada's operational and developmental NWP models

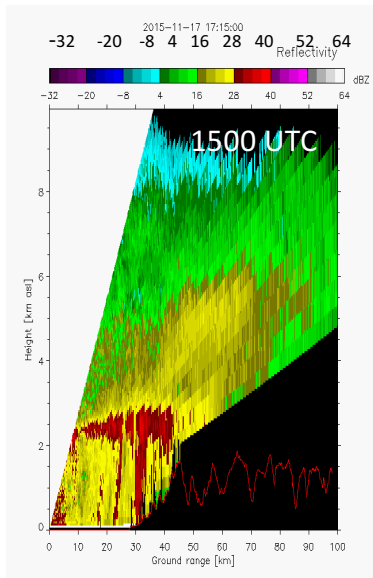
ECCC Olympex data sets collected

Site	Dataset	Format	Status
Univ. of Victoria	Upper Air Soundings	Up to every 3-h during events 2-sec res ASCII tables	Real-time feed to Olympex data portal Raw Digicora .dc3db files also available
Albert Head	Surface station	1-min raw message capture <ul style="list-style-type: none"> • Parsivel2 disdrometer • Pluvio400 weighing gauge • WXT520 compact wx station • FD12P present wx system 	Real-time feed to Olympex data portal Plots and csv time-series tables reprocessed and uploaded
Albert Head	Dual-pol X-band radar	SELEX Rainbow5 system 5-min cycle (3 PPIs, 5 RHIs + Birdbath) Base params (level 1A): <ul style="list-style-type: none"> • udBZ, dBZ, V, W, RhoHV, SQI, ZDR, uPHIDP Processed params (level 1B): <ul style="list-style-type: none"> • PhiDP Filtered and KDP Derivation • Dual-Pol based Attenuation Correction (dBZ, ZDR) 	Level 1A (1 file per param) dataset forwarded to NASA <ul style="list-style-type: none"> • Currently working on multi-param repacking and full ingest into ODIM_H5 format Rainbow re-ingest to produce level 1B params TBD

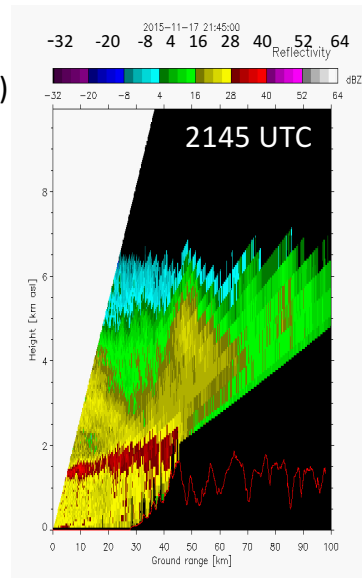
Warm Moist Flow and a Narrow Cold Frontal Rainband

(11/17/2015)

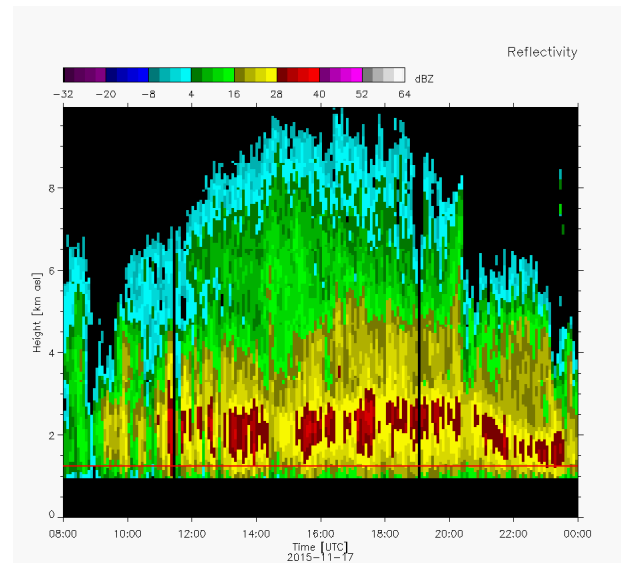
- Heavy rain over Hurricane Ridge
 - Warm-sector until 21:00
 - Bright-band descent (21:00-22:00) indicates cold frontal passage



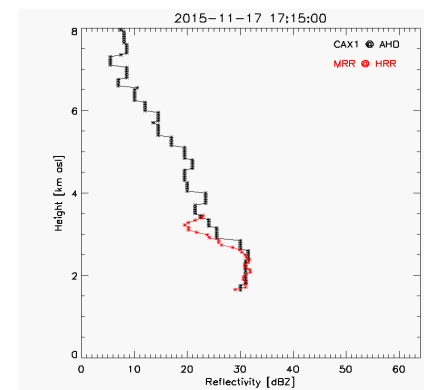
Ze (dBZ)



CAX1 RHIs



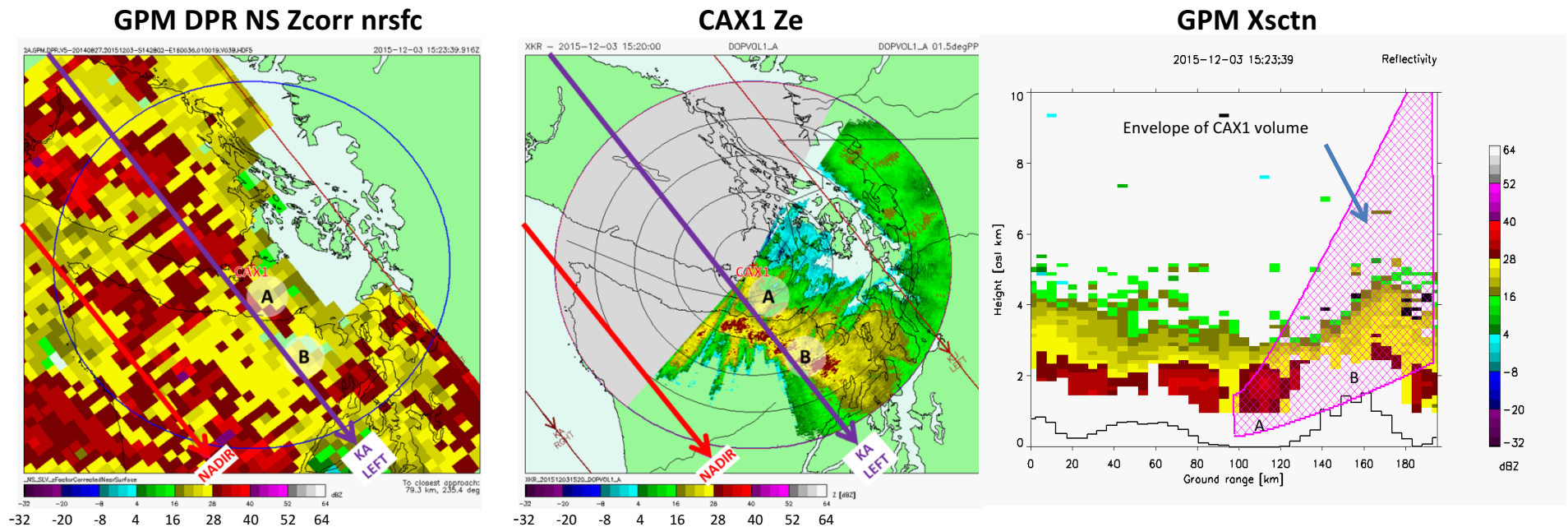
Time-height (HTI) cross-section, constructed from 5-min scans over Hurricane Ridge (181°, 41-km)



Vertical profile of Ze at Hurricane Ridge at 1500 UTC
(CAX1 black, MRR red)

GPM overpass

- 12/03/2015: GPM core observatory passed over Olympics during passage of complex baroclinic system



Comparison:

A: $DBZ_{GPM} > DBZ_{CAX1}$ bright-band
 B: $DBZ_{GPM} < DBZ_{CAX1}$ ground clutter

Hudak David, Peter Rodriguez, Norman Donaldson, and Daniel Kirshbaum, 2016:
 OLYMPLEX CANADA. 17th Conference on Mountain Meteorology, Amer. Meteor. Soc.,
 paper 5.3



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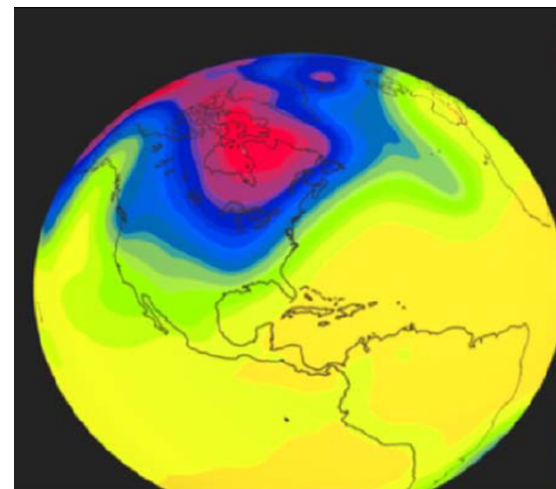
Canadian Arctic

Year of Polar Prediction (Mid 2017 to mid 2019)

- a period of intensive observing, modelling, verification, user-engagement and education activities.

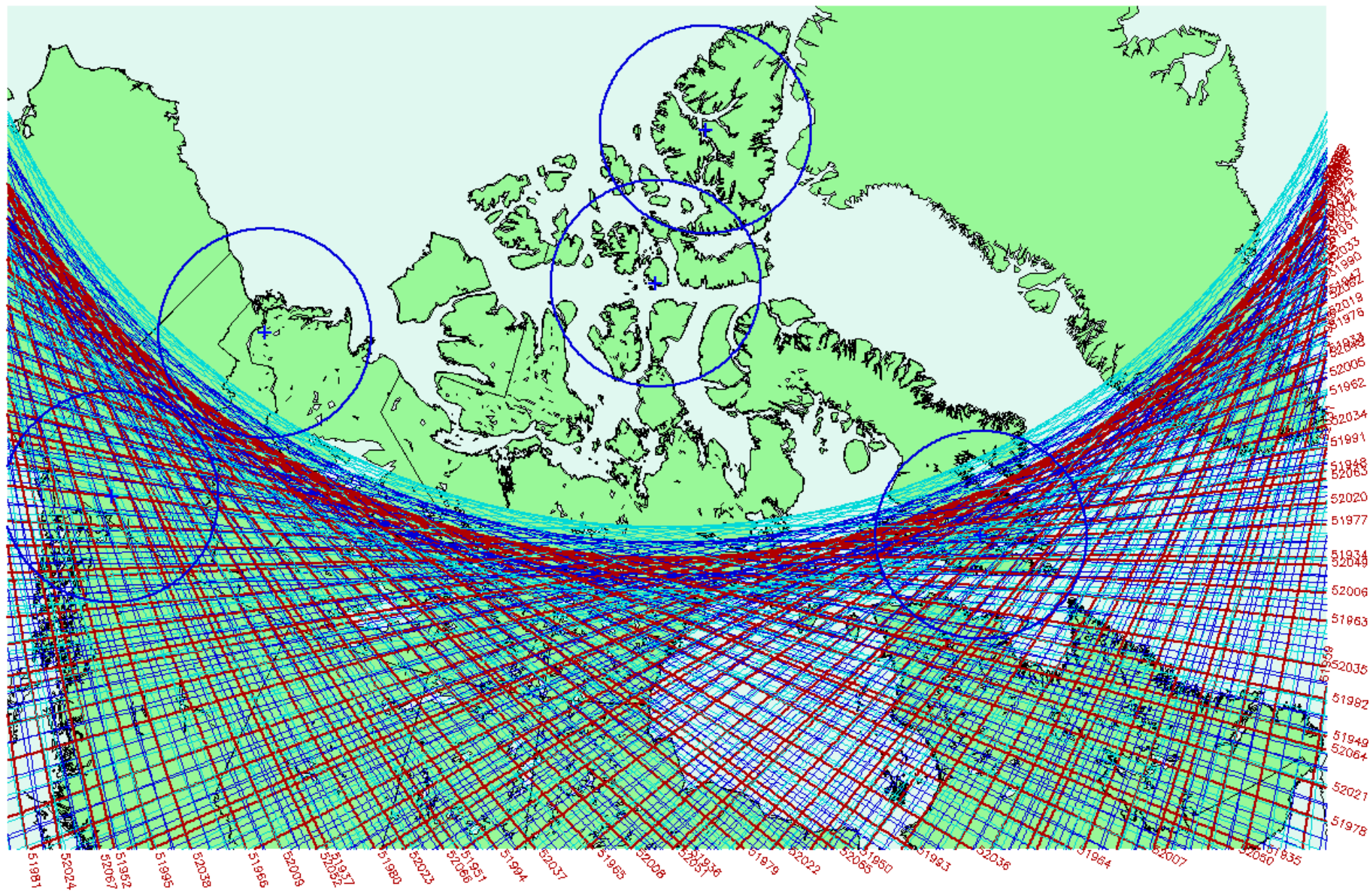
Overarching aim: Improving weather and climate forecasting in the polar regions, through a better understanding of key physical processes and an improved representation of those processes within numerical weather and climate prediction systems.

- Arctic weather systems impact significantly the most populated areas in Canada
- Activity in the Northern areas of Canada is fast growing
- Relevant and reliable weather information is needed to protect people and the environment



GPM: 10_DAYS

GPM: 2016-02-10



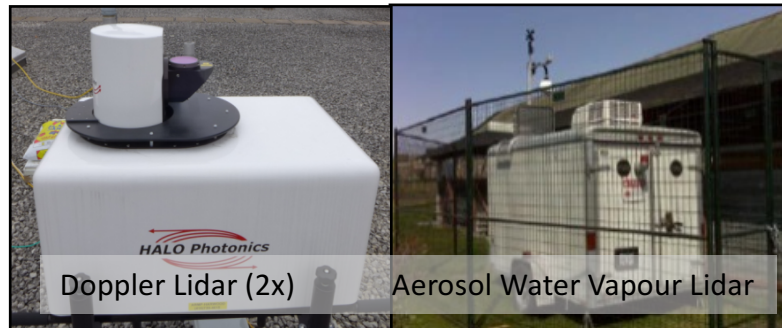
63.74N 68.51W 11m

Iqaluit Supersite

(Eastern Arctic, Coastal)



Ka Band Scanning Dual-Pol Radar



Doppler Lidar (2x)

Aerosol Water Vapour Lidar



Radiometer

Ceilometer

Scintillometer + Flux

Precip Test site

60.71N -135.06W 682m

Whitehorse Supersite

(Western Arctic, Complex Terrain)



X Band Dual-Pol
Doppler Radar



Doppler Polarization
Scanning Lidar

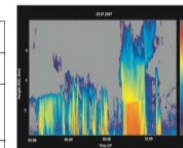
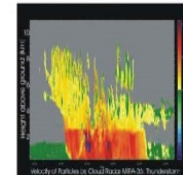
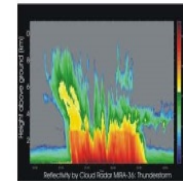


Cloud Radar MIRA-35

Typical Applications

- Research in meteorology
- Wake vortex monitoring
- Icing hazard detection
- Cloud particle characterization
- Eddy correlation fluxes
- Wind shear detection
- Synergy with other remote sensing instruments
- Fog detection and nowcasting
- Meteorological networks
- Research stations
- Industrial sites
- Airports
- Marine and offshore platforms
- Wind energy
- input for weather prediction
- Sport events

MIRA-35 is a Ka-Band Doppler radar with high sensitivity allowing to observe even light clouds. It is designed for unattended long-term operation. MIRA-35-S is mounted on a pedestal allowing elevation and azimuth scanning within zenith angles from -90° to +90° and azimuth angles from 0 to 360° (continuous rotations).



Transmit Frequency	33 – 37 GHz, 35.2 GHz recommended by ECC
Peak Power / Average Power	30 kW / 30 – 60 W
Sensitivity	- 53 dBZ (5 km range, 30 m range resolution and 10s time resolution, 1m antenna)
Max. Measuring Range	Depending on pulse width and PRF up to 60 km
Min. Measuring Range	150 m full sensitivity above 450 m
Max. Number of Gates	1000
Min. Time Resolution	0.1 s
Beam Width	0.5° with 1 m and 0.3 with 2 m antenna
Antenna Diameter	1 m, 1.2 m, or 2 m
Pulse Width	100 – 400 ns
Pulse Repetition Frequency	2.5 to 10 kHz
Velocity Resolution	5 cm/s
Polarization Parameters	Linear polarization on transmit, co and cross polarized signals are received simultaneously. LDR and co-cross-correlation can be computed. Alternatively STAR mode can be provided.
Dimensions of the radar electronics	Transmitter 19" Chassis 9 U, Receiver 4 U, PC 4 U (depth of all units 530 mm).
Power consumption depending on the duty cycle	Radar: 950 W at 1/500 600 W at 1/1000 PC+DSP 150 W Air Conditioning 800 W for the vertically viewing and 1.6 kW for the scanning system.

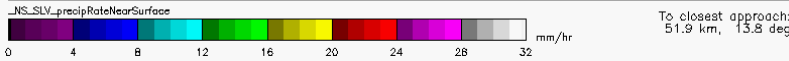
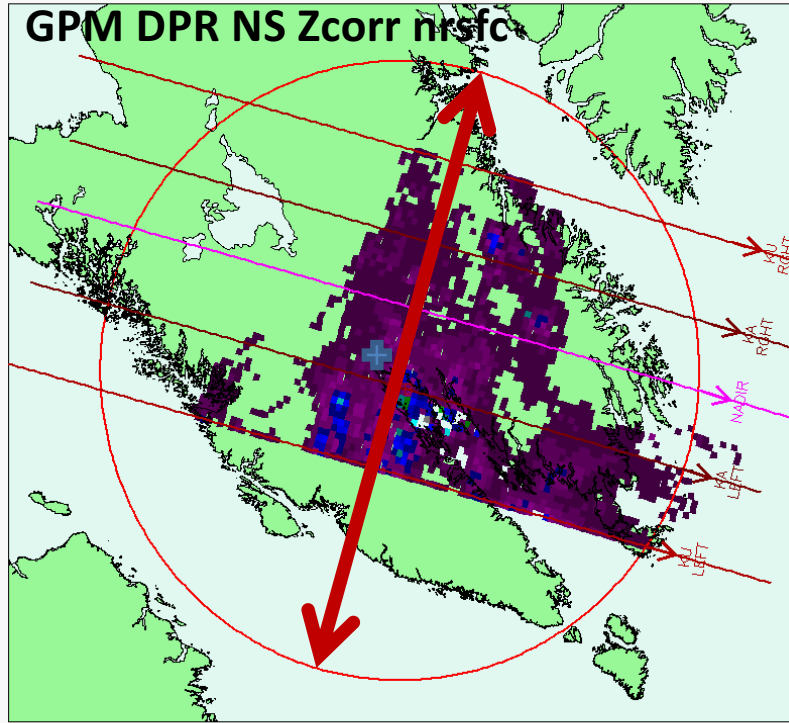


METEK GmbH, Fritz-Strassmann-Str. 4, 25337 Elmshorn, Germany
Phone: +49 4121 43590, Fax: +49 4121 4359 20
E-mail: info@metek.de, Internet: <http://www.metek.de>

2013-10-10

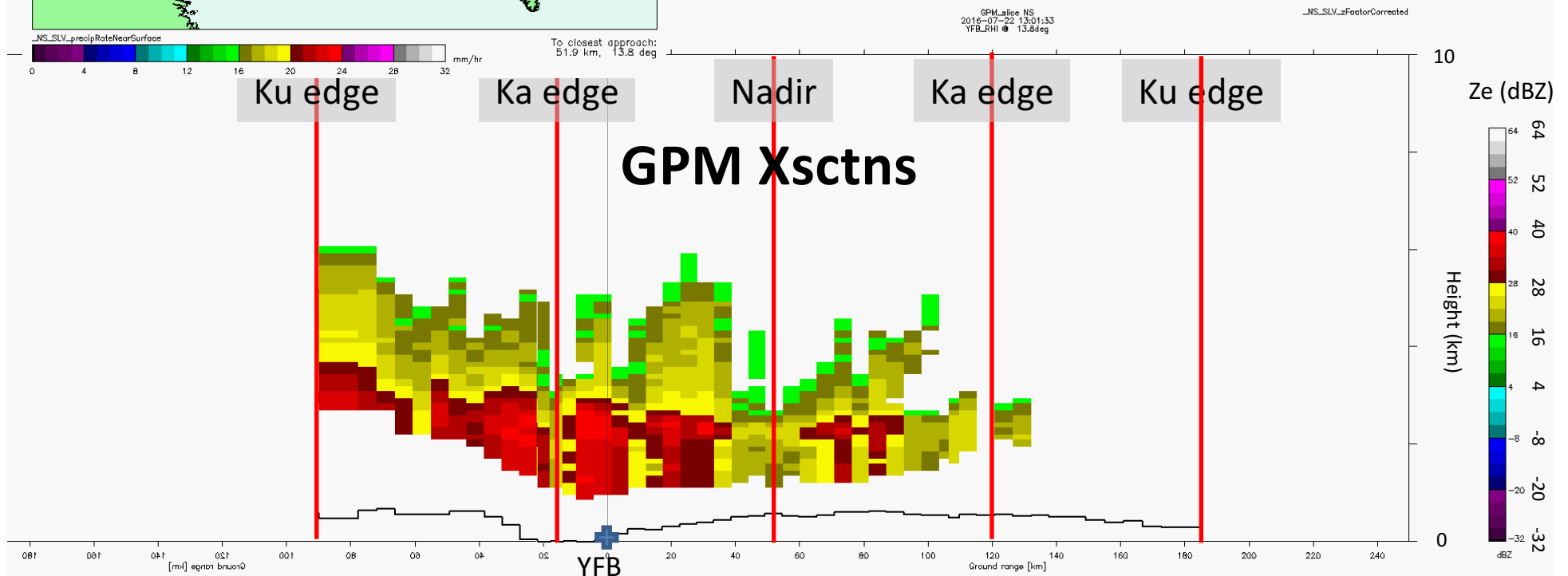
YFB - 2016-07-22 13:00:00

2A GPM DPR V6-20160118 V04A



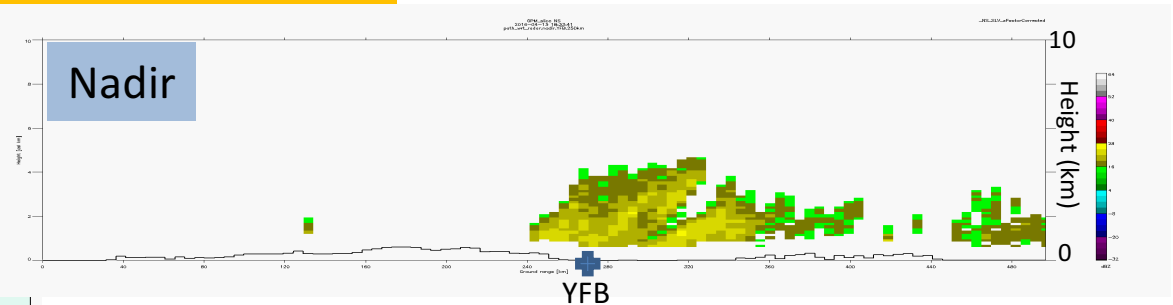
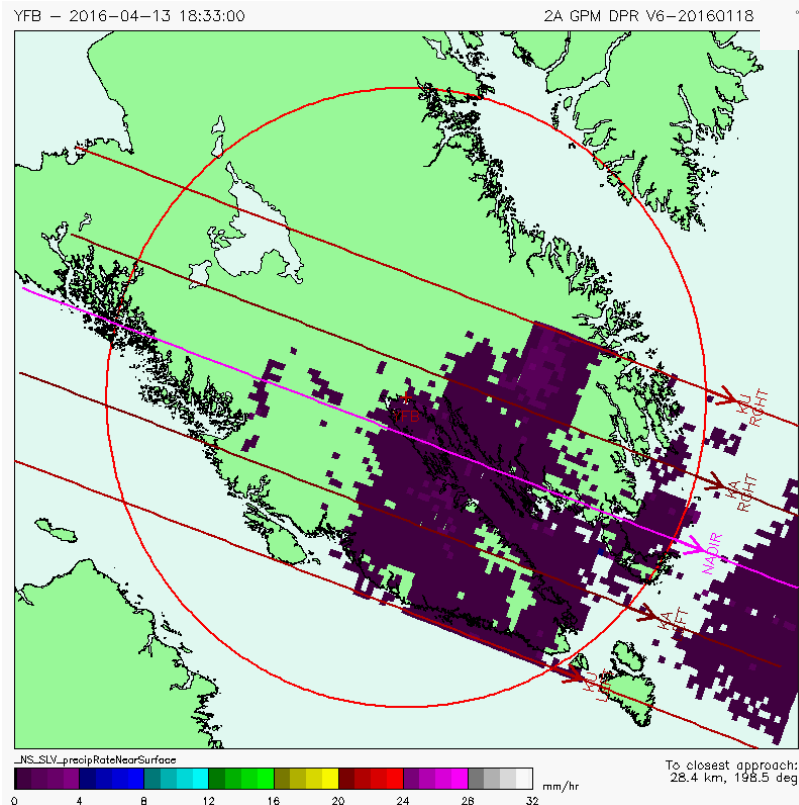
To closest approach:
51.9 km, 13.8 deg

GPM over pass at Iqaluit (YFB) 2016-07-22 1301 UTC

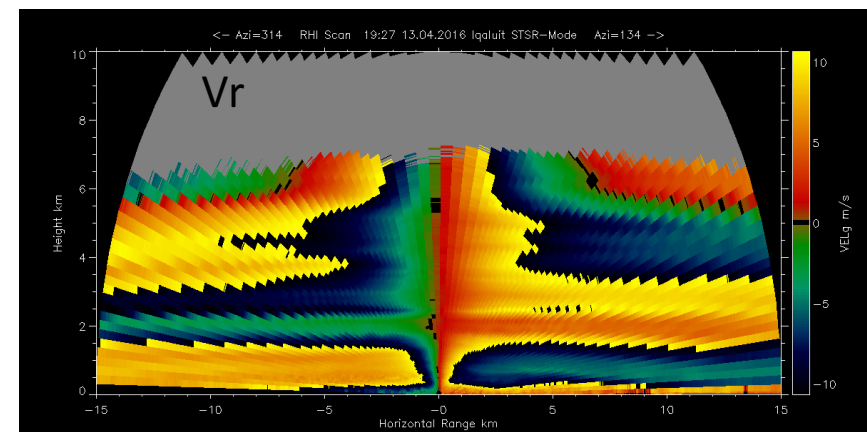
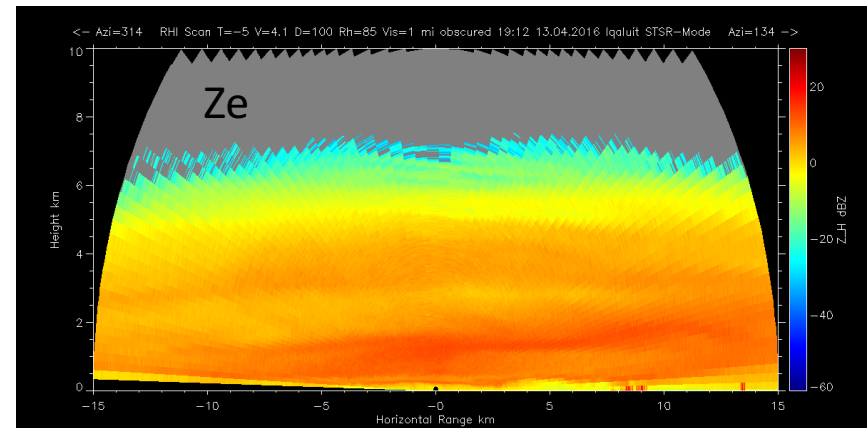


GPM over pass at Iqaluit (YFB) 2016-04-13_1833 UTC

SNOW event



Ka-Band Radar at YFB
RHI on 134°



Summary

- Physical validation of DPR L2 products supports many ECCC Strategic Objectives:
 - Assess quality of the GPM measurements in different climate regimes of Canada
 - Promote the development of hydrological applications making use of GPM
 - Support model validation and data assimilation in Canada's operational and developmental NWP models
 - Supports the development of an integrated observing system that combines ground based, satellite and airborne observations particularly in the Canadian Arctic (Year of Polar Prediction)

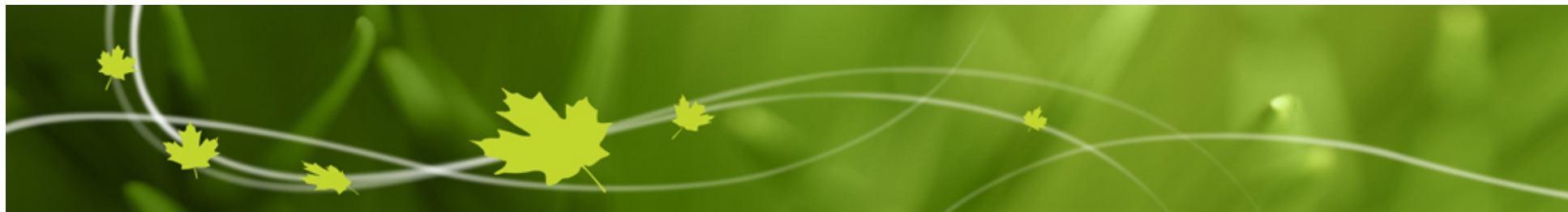




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Thank you/Merci

2016 PMM Science Team Meeting, Houston, TX, October 24-28, 2016